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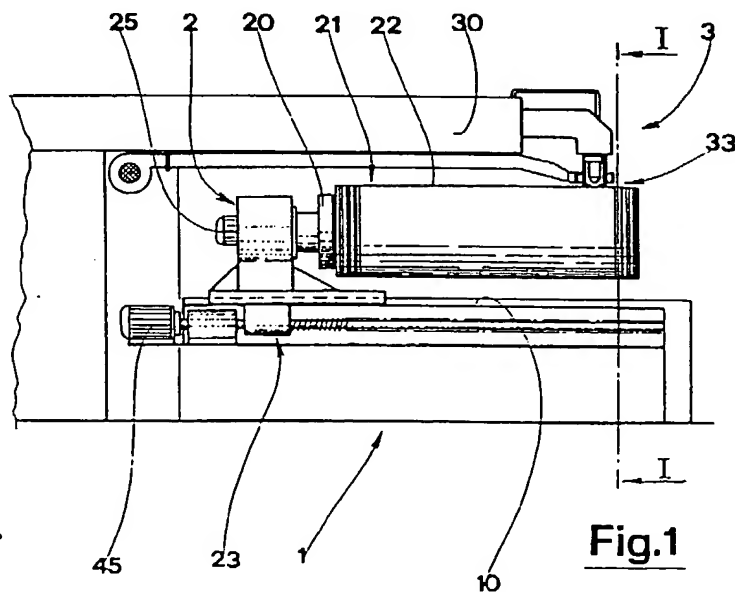
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**I-41100 Modena (IT)**(54) **An apparatus for engraving on a rubber cylindrical matrix.**

(57) The invention relates to an apparatus for engraving rubber cylindrical matrices. It comprises a motor head (2) provided with a chuck (20) on which a matrix-bearing cylinder (21) provided with a smooth

external cylindrical rubber surface (22) can be mounted. An engraving head (3) employs a laser beam predisposed perpendicularly to the external cylindrical surface (22) of the cylinder (21).

**Fig.1****EP 0 677 384 A2**

The invention relates to an apparatus for engraving on rubber cylindrical matrices.

Specifically but not exclusively the apparatus is useful for realising, by means of engraving, matrices on matrix-bearing cylinders, provided with at least one external peripheral part which is elastically deformable, used in decoration and glazing of ceramic tiles.

Particular reference is made to matrices engraved on smooth cylindrical surfaces made in silicone rubber, which are constituted by patterns composed of a plurality of microscopic cavities predisposed to house small quantities of glaze.

The cavities, usually distributed over all of the cylindrical surface, can be of various sizes and thus can contain various quantities of glaze. This possibility of variety has the aim of enabling various quantities of glaze to be transferred on to the tiles, in order to obtain a good half-tone quality thereon.

Flexographic cylinders are already well known wherein lasers are employed to engrave on the elastic surface. The most common alternative to the above is the photoengravure technique.

Engraving on a flexographic cylinder, including techniques employing the use of a laser, is effected by removing material from the cylinder surface such as to leave a relief pattern on said surface, which protruding pattern therefore constitutes the active surfaces for the transfer of the ink or the glaze on the support to be printed on.

The above-illustrated prior art therefore engraves on the material, removing it, thus constructing a pattern to be printed or reproduced. It is therefore unsuitable for the reticulation technique necessary for the creation of half-tones.

The present invention, as it is characterised in the claims that follow, obviates the above-mentioned drawbacks by providing a versatile apparatus able to realise a matrix constructed in points and with a high degree of resolution.

One advantage of the present invention is that it can be totally automatised, thus permitting an automatic and direct reproduction of patterns by CAD-CAM techniques.

Further characteristics and advantages of the present invention will better emerge from the detailed description that follows, of an embodiment of the invention, illustrated in the form of a non-limiting example in the accompanying drawings, in which:

figure 1 is a schematic vertical-elevation frontal plan view;

figure 2 is a schematic plan view from above of figure 1;

figure 3 is an enlarged-scale detail of a schematic section made according to line I-I of figure 1;

figure 4 is a schematic section made according to line III-III of figure 3;

figure 5 is an enlarged-scale schematic section made according to line IV-IV of figure 4;

figure 6 is a block diagram of the control system of the invention.

With reference to the figures, 1 denotes in its entirety a frame provided with straight horizontal guides 10 on which a motor head 2 is coupled. The motor head 2 is provided with a chuck 20 rotatingly mobile about an axis which is parallel to the sliding direction along the guides 10.

The chuck 20 is equipped and predisposed such that a special matrix-bearing cylinder 21 can be mounted to it, said cylinder 21 exhibiting a smooth elastically-deformable cylindrical surface 22.

The matrix-bearing cylinder 21 comprises an external layer made in silicon rubber and covered by the smooth cylindrical surface 22, which latter constitutes the cylindrical "printing" surface, destined to come into contact with the tile or the like, and which is therefore the surface on which the engraving process takes place.

The chuck 20 and thus the cylinder 21 solid thereto are set in rotation about their axis by a motor 25, controlled by a driver 15. The entire motor head 2 is mobile along the guides 10, driven by a worm-wheel gearing 23 activated by a motor 45 commanded by a driver 35.

The apparatus is thus controlled on two axes - the rotation of the chuck 20 and the translation of the motor head 2 - controlled by an axis control unit 5 commanding the two drivers 15 and 35.

The above-described system enables the cylinder 21 to be positioned at any single point with respect to a fixed point, and with a high degree of precision.

An engraving head 3 is arranged on the frame 1, and comprises a source 30 of a laser beam 31 having its axis directed perpendicular and incident with the chuck 20 rotation axis and therefore perpendicular to the smooth cylindrical surface 22 of the cylinder 21. The laser source used in the embodiment of the figure is a CO<sub>2</sub> laser with a wavelength of 10.6 micrometers, superpulsed and characterised by a continuous 120 watt potential.

The laser beam is focalized by a focalizing device 32 at a prefixed distance from the contact surface of a spacer skate 34, fixed to the head 3 and predisposed to contact draggily on the external cylindrical surface 22 of the cylinder 21. The focalizing of the laser beam 31 on the surface 22 is performed by means of a collar 38 enabling the distance between the focalizing device 32 and the skate 34 to be varied. The skate 34 maintains the external cylindrical surface 22 of the cylinder 21 at a preestablished distance from the focalizing de-

vice 21.

The laser 30 is controlled by a command unit 4 directly connected, as is the axis control unit 5, to a computer 6. The computer is in turn connected to a graphics station 7 by means of which matrix patterns can be made and memorized.

Through the computerized system, the matrix patterns are analyzed and transformed into a map of uniformly-distributed points or small areas, each of which is characterized by size. Each point on a map corresponds to at least one dosed application of the laser beam 31. The laser beam force is determined by a prefixed combination of the pulse power and duration. The power-duration combination of values is transmitted by the computer 6 to the command unit 4. The laser beam action on the cylindrical surface 22 produces a vaporization or melting of the material in the interested zone, and the exported material is continuously removed by an air or inert gas blower 33 operating at the focalizing device 32 position and having the task of keeping the device scrupulously clean. The air or inert gas is channelled parallel to the laser beam 31 and exits from a nozzle 37 in a perpendicular direction to the surface 22. The action of the thus-generated jet facilitates extraction and expulsion of the material removed during the generation of a single cavity 24. An aspirator 36 collects the removed material.

The axis control unit 5 positions the surface area 22 to be shaped below the focalizing device 32. The positioning is executed with great precision and very high resolution: on average the resolution varies from 0.1 to 0.8 millimeters. For each positioning (which does not require stopping the cylinder) the head 3 emits a laser pulse modulated according to the breadth and depth of the cavity 24 to be engraved at that position. The relevant information regarding the variety of breadth and depth of the different cavities is communicated by the computer in accordance with the information contained in the graphics program.

By moving the cylinder 21 a map of cavities 24 can be realized, spaced one from another by various distances, for example between 0.1 and 0.8 millimeters and having similar (variable) ranges of depths. In particular, by way of an example, the CO<sub>2</sub> laser (with a 10.6 micrometer wavelength), superpulsed at 120 watts (continuous), five thousand cavities per second can be made on the surface 22, each cavity having a diameter of about 0.1 millimeters by a depth of 0.1 millimeters.

#### Claims

1. An apparatus for engraving a cylindrical rubber matrix, characterized in that it comprises:
  - a frame (1);

- a motor head (2) bearing a chuck (20) rotatably mobile about an axis; said chuck (20) being predisposed such that a special matrix-bearing head (21) provided with a smooth rubber cylindrical surface (22) can be mounted thereon;
- straight guides (10) arranged parallel to a rotation axis of the chuck (20) the motor head (2) being mounted and translated thereon;
- means for rotating the chuck (20) and translating the motor head (2) along the guides (10);
- at least one engraving head (3) comprising:
  - at least one source (30) of a laser beam (31) having an axis which is perpendicular and incident to the rotation axis of the chuck (20);
  - a focalizing device (32) of the laser beam (31);
  - a blower (33) of air or gas operating at the position of the focalizing device (32) and having a task of cleaning the device and of facilitating evacuation of material removed from the cylindrical surface (22) by the action of the laser beam (31);
  - a spacer skate (34) to draggably contact the external cylindrical surface (22) of the cylinder (21) placed in proximity of the part of the surface (22) struck by the laser beam (21) at a prefixed distance from the focalizing device (32);
  - a command apparatus commanding a precise positioning of the external cylindrical surface below the focalizing device (32) as well as activating a command unit (4) of the laser source (30);
- said apparatus being predisposed to read, analyse and transform a pattern into a map of uniformly distributed points or small areas, each having individual dimensions;
- at least one programmed application of the laser beam (31) being effected for each dimension of each point or small area.

2. An apparatus as in claim 1, characterized in that the means for rotating the chuck (20) and translating the motor head (2) along the guides (10) comprise an axis command unit (5) which in turn comprises:
  - a driver (15) of the motor (25) producing a rotation of the chuck (20);
  - a driver (35) of the motor (45) commanding a translation of the motor head (2) along the guides (10) by means of a

worm-worm wheel gearing (23).

3. An apparatus, as in claim 1, characterized in that the laser source (3) comprises a CO<sub>2</sub> laser generating pulses, each of which pulses is power-and duration-adjustable and provides a quantity of energy in accordance with the dimensions of a single cavity (24) to be engraved.
4. An apparatus as in claim 1, characterized in that a distance between the focalizing device (32) and the skate (34) is constant; a variation in an effect of the laser beam (31) on a single point or small area of the surface (22) being determined by a total energy with which the point or small area is struck thereby.
5. An apparatus as in claim 1, characterized in that the command apparatus comprises a computer (6) connected to a graphics station (7).
6. An apparatus as in claim 1, characterized in that for each said point or small area a prefixed energy supply corresponding to at least one application of the laser beam 31 is determined by a preestablished combination of power and duration of the pulse.

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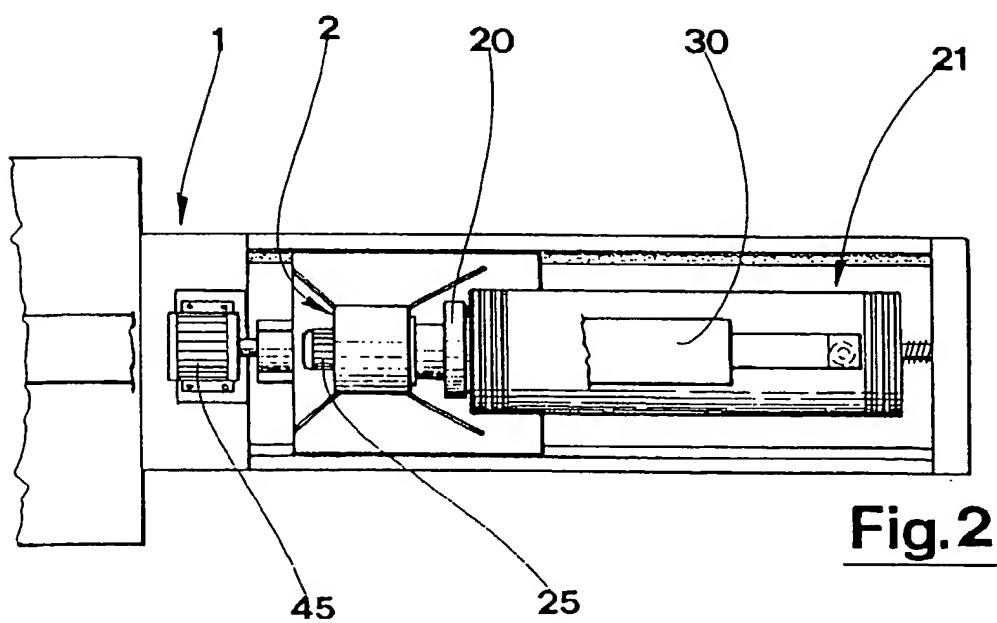
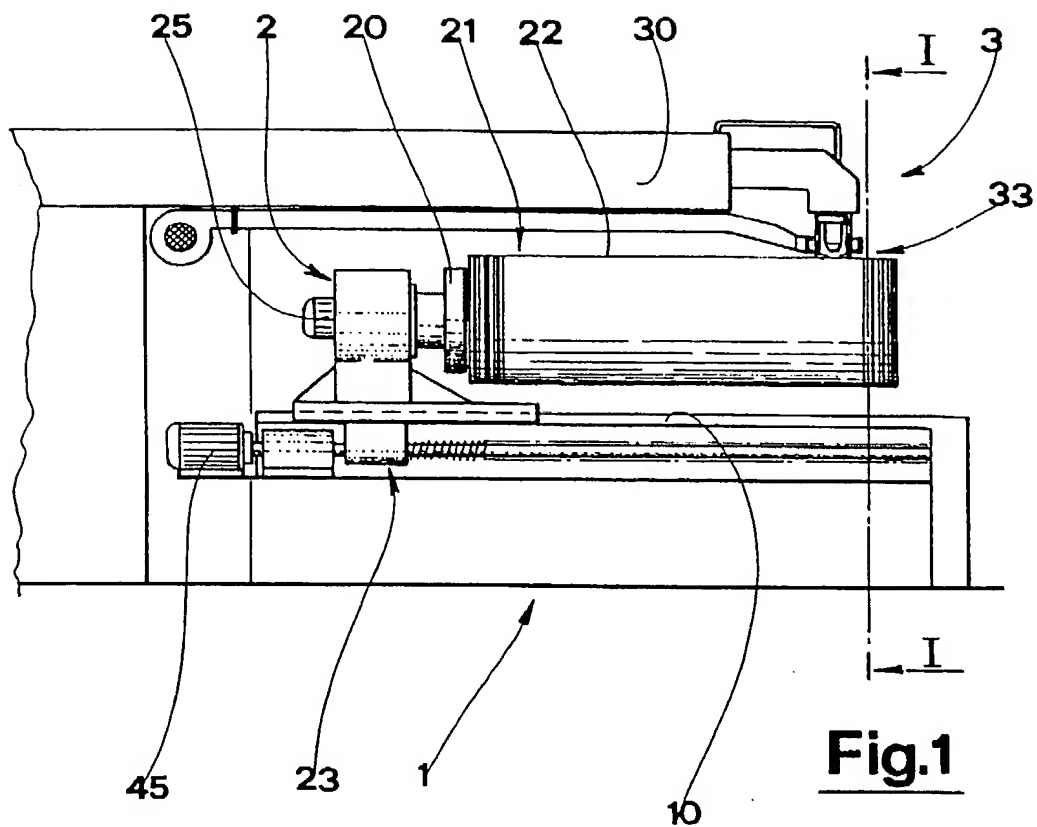
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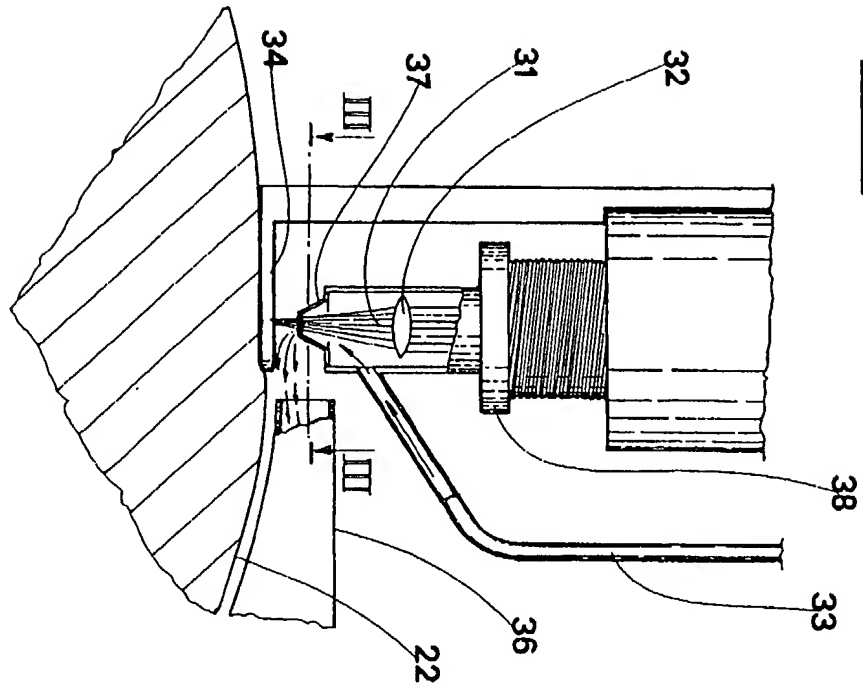
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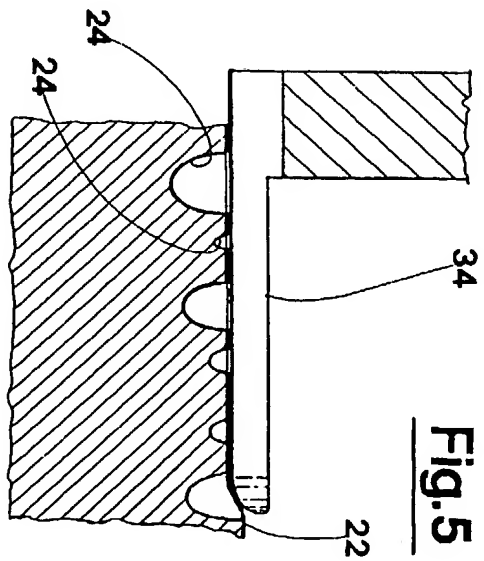
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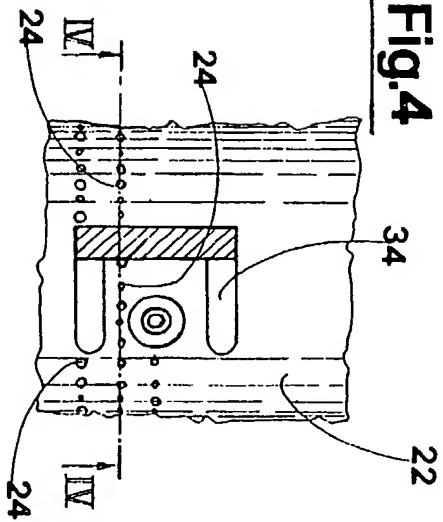
**Fig. 3**



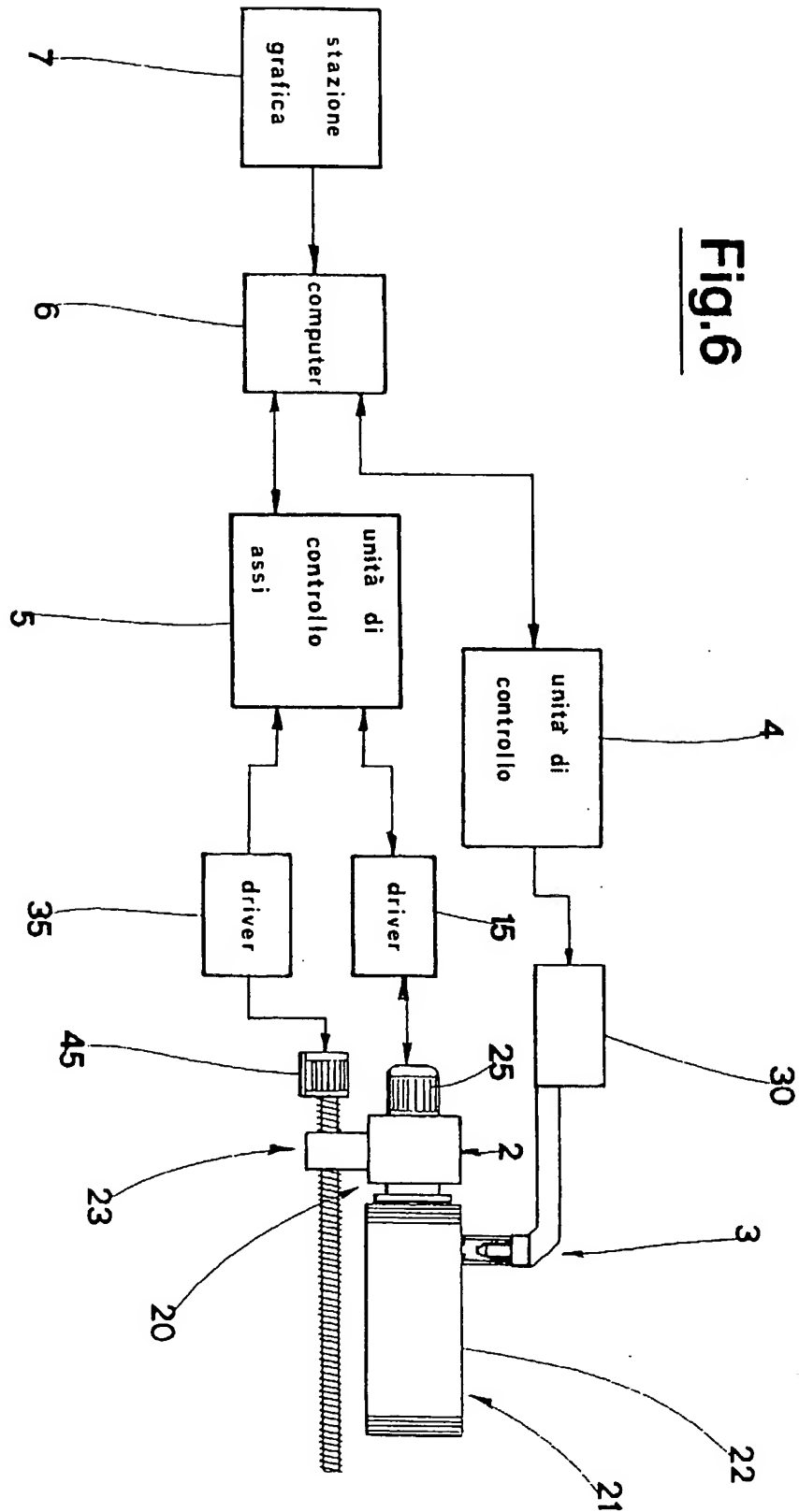
**Fig. 5**



### Fig. 4



**Fig.6**





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12

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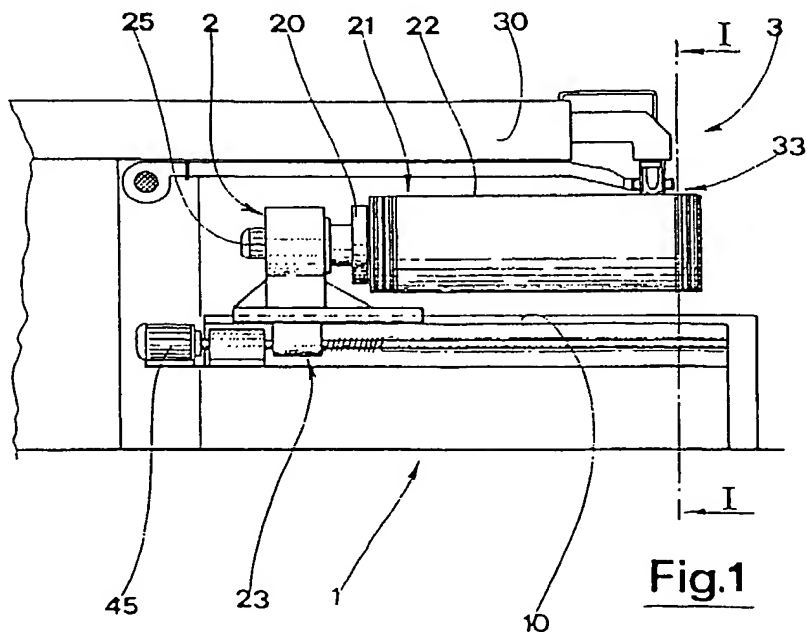
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**Fig.1**

EP 0 677 384 A3





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## EUROPEAN SEARCH REPORT

Application Number  
EP 94 83 0492

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	WO-A-93 23253 (DU PONT) 25 November 1993 * page 1, line 15 - page 2, line 9 * * page 30, line 5 - line 9 * ---	1,3	B41C1/05
A	US-A-2 574 872 (F. W. JARVIS) * column 4, line 19 - line 54 * ---	1,2	
A	GB-A-2 048 785 (CROSFIELD ELECTRONICS LTD) 17 December 1980 * abstract * ---	1	
A	EP-A-0 421 712 (CANON KK) 10 April 1991 * abstract * -----	3,4,6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B41C H04N
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 10 October 1995	Examiner Hazel, J
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EP 94 83 0492 (P4/CU)